Diamonds 2012 R01 release information
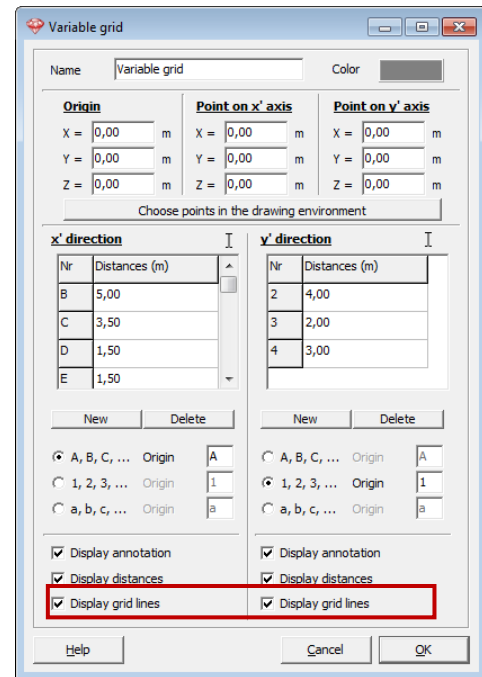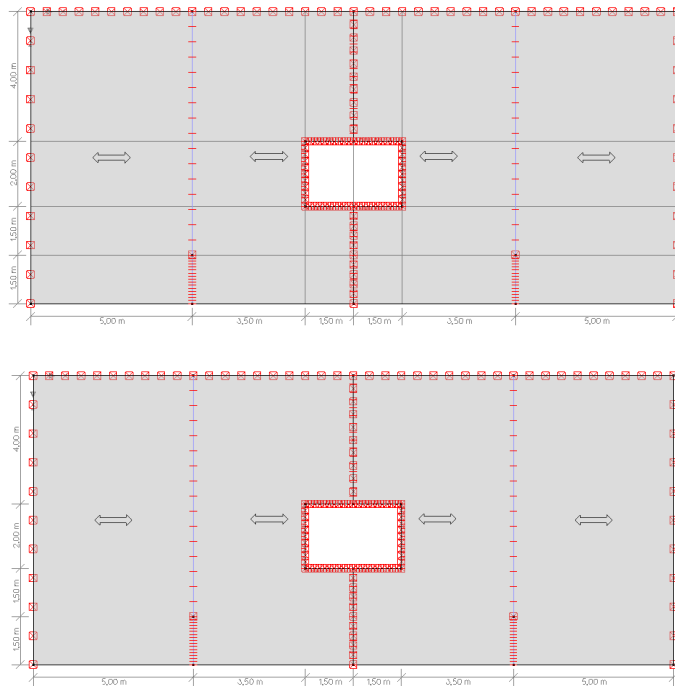
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1. Geometry

1.1. Display grid lines of variable grid

In Diamonds 2012 R01, you can choose to display the grid lines of a variable grid. If you do not display them, you have the option to use the variable grid as a dimension tool.

1.2. Modifications on the material library

1.2.1. Concept of the material library

The material library is extended in Diamonds 2012 R01. Extra options allow you to define different properties for each material and for each design code (including National Annex). Click on 'Edit -> Material library' in order open the library.

Materials with in the Buildsoft icon ⬚ in front are standard materials. Materials with a user icon ⬚ in front are user defined materials. It is not possible to edit standard materials.

Tip: However, it is possible to copy a standard material. This new material is fully editable by the user.

Select now a material type steel, for example S235, and click on Advanced parameters .
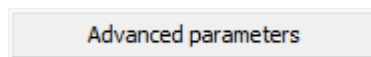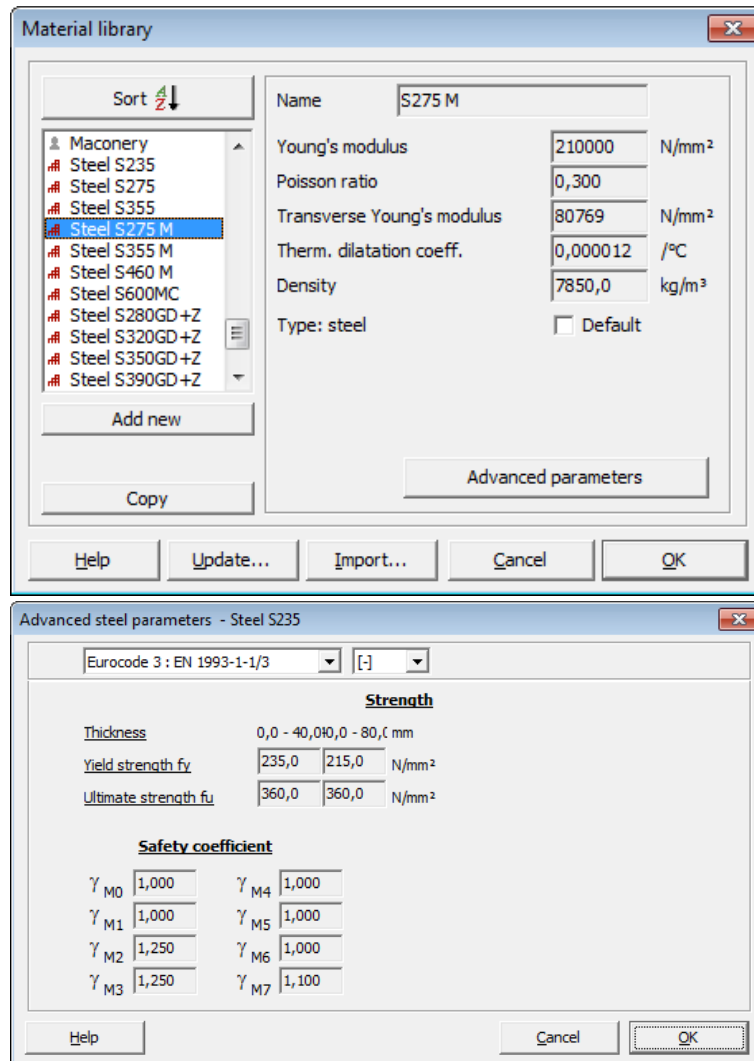
Let us look at the functions of this screen:

- In the title bar, you see the name of steel type, for which you have requested the properties In this case S235.
- In the **first dropdown menu**, you select the design code for which you want to inspect the material properties
- In the **second dropdown menu**, you select the corresponding National Annex – in case of Eurocode (remark: there are no national annexes for timber). In the window below, we have selected the European design code Eurocode EN 1993-1-1/3 with national annex for Belgium.
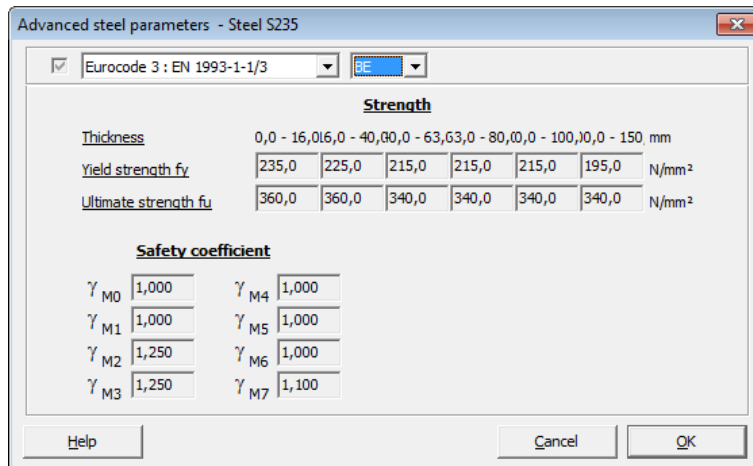
- If the option on the left side is checked, it means that the design code in question with national annex is different from the basic design code (with no national annex)

  - For standard materials, you cannot change this option.
  - For user defined materials, you check this option if you want to enter different material properties for each national annex, overriding the basic design code with no national annex.

2. Loads

2.1. Extension of wind generator

As from Diamonds 2012 R01, you will see following dialog window:

- In the **upper part**, you can see a copy of the selected bars. The bars in bold represent the outer contour, automatically detected by Diamonds. Based on this contour, Diamonds will determine the wind loads.
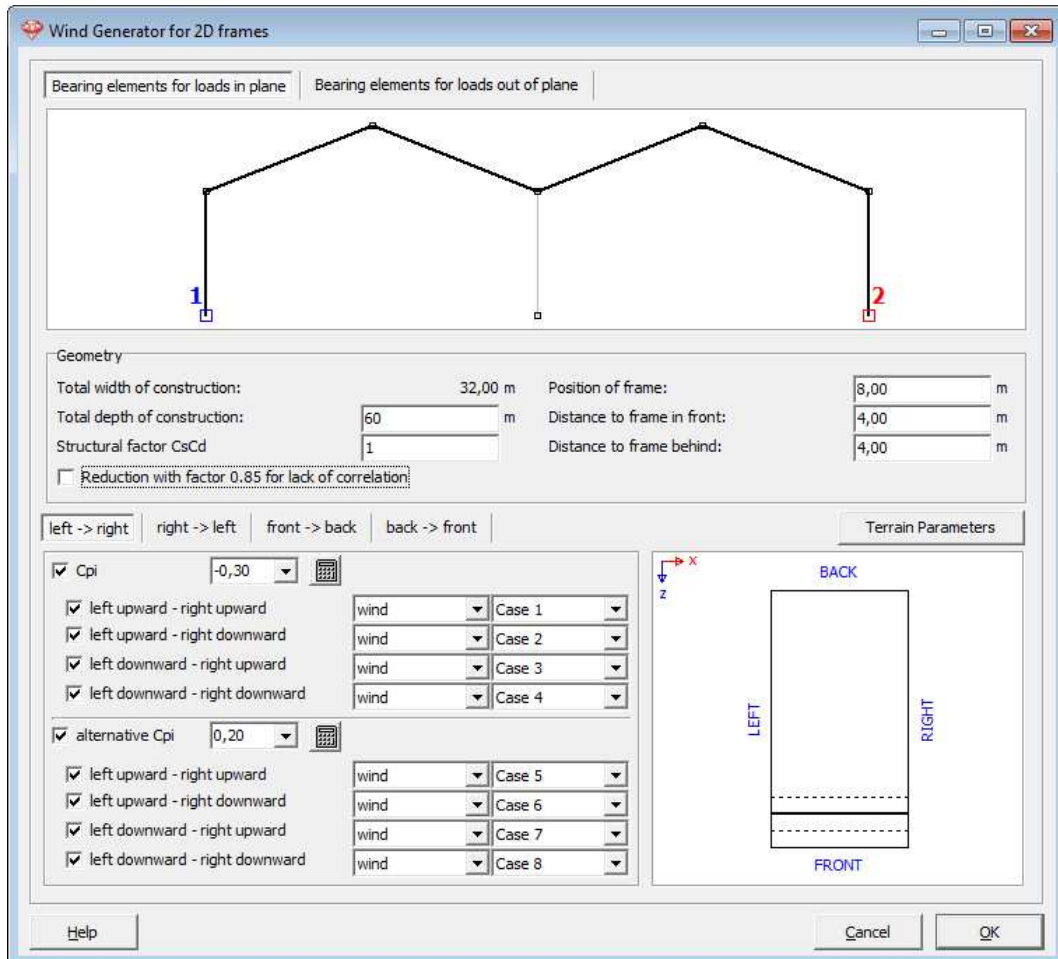- In the **'Geometry' box**, you enter the structure's depth, the position of the current selected 2D frame, with respect to the front side (FRONT) and the distance to the frame in font and the one behind. The image on the right hand side shows you a top view of the selected frame, with respect to the front and back of the complete building. The frames behind and in front are also shown (in dotted line). The axes in the left upper corner define clearly the structure's orientation.

  Finally, you can indicate whether you want to take into account the lack of correlation between the left and right side. If you check this, wind on the vertical sides will be reduced with a factor 0.85. In Belgium, Luxemburg and France, this is not allowed, however, you may use in the Netherlands.

- In the **4 tab pages**, 'left -> right, 'right -> left, 'front -> back et 'back -> front', you can check which wind loads should be generated, and with what internal pressure coefficient c_{pi} the wind load should be calculated.

  Note that Diamonds can generate **up to 24 different wind load cases**: 12 with internal pressure coefficient $c_{pi,1}$ and (if you want this) 12 others with an alternative internal pressure coefficient $c_{pi,2}$ (see annex 2).

- Clicking the button Terrain Parameters , allows you to define the terrain parameters, necessary to calculate the wind pressure.

The new parameter in this window is the **probability factor c_{prob}**. This factor takes into account the design life time. A probability factor $c_{prob} = 1$ equals a design life time of 50 years. If you have indicated another design life time in the load factor windows, Diamonds will determine the probability factor c_{prob} according to EN 1991-1-4 §4.2 Note 4.

2.2. Extension of the snow generator

On opening the snow generator in Diamonds 2012 R01, you'll see following window:

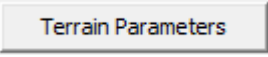Running through the contents of this window:

- In the **upper part**, you can see a copy of the selected bars. The bars in bold represent the outer contour, automatically detected by Diamonds. Based on this contour, Diamonds will determine the snow loads on all horizontal and inclined bars.
- In the **central part**, indicate the region for which you want to generate the snow loads. The snow load at ground level is based the choice of country, the zone and the region.
- Here also, you have the possibility to take into account the design life time. This reduction is allowed in in Belgium, Luxemburg and the Netherlands, but not in France.
- Enter a value for the exposure coefficient c_e and thermal coefficient c_t. In Belgium, Luxemburg and the Netherlands, the exposure coefficient c_e is always 1. In Belgium, Luxemburg, France and the Netherlands, the thermal coefficient c_t is always 1.

- Finally, check in the **lower part**, which snow loads should be generated and what load cases they should be put in. Note that Diamonds can generate up to 6 different snow loads at once. (See annex 3).

2.3. Combinations according to American standard

Other EN 1990, NEN 6702 and CTE, you can now use the American standard AISC 07-10 for the load combinations.

2.3.1. Changes in the load case window

In order to generate the combinations according to AISC 07-10, you have to start with the definition of the load cases $\gamma_g^{\gamma_u}$, just like you would do for Eurocode.
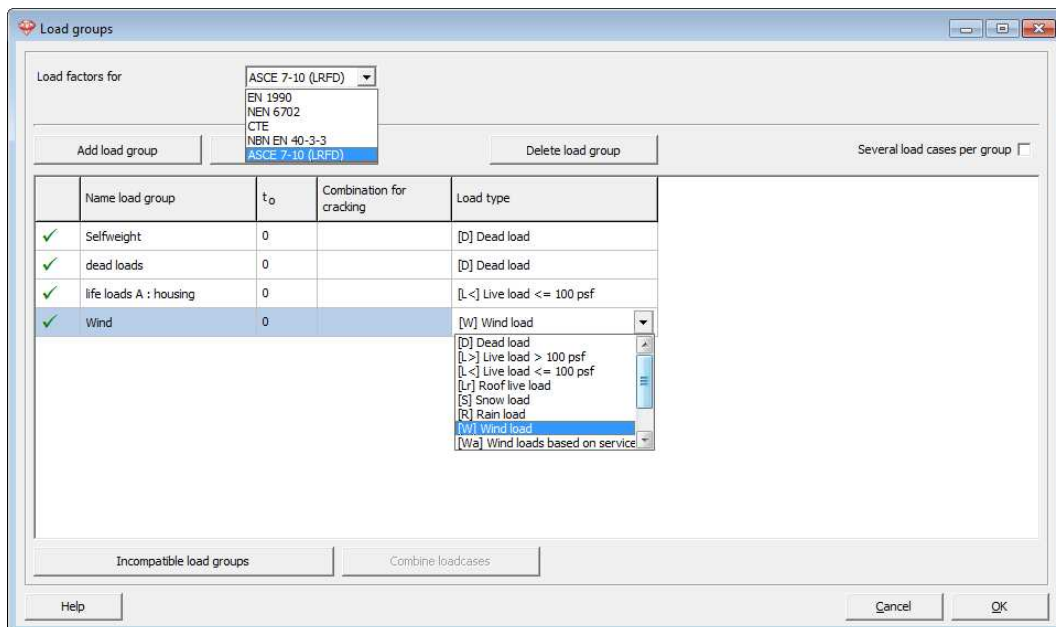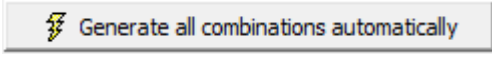
Let us walk through this window:

- In the **first column**, you indicate whether a load case should be taken into account or not in the analysis.
- In the **second column**, you give the load case a name.
- In the **third and fourth column**, you can add t_0 and the combination for cracking. There parameters are only useful in case of concrete calculations.
- In the **last column**, you specify the type of loads. Diamonds will know what safety factors to use for this load. Diamonds has several types of loads:

  - Dead load [D]
  - Live load [L<]: $\leq$ 100psf
  - Live load [L>]: $>$ 100psf
  - Roof live load [Lr]
  - Snow load [S]

- Wind load [W]:
- Wind load [Wa]: wind for service limit state
- Earth, groundwater, bulk materials with permanent character [H-]
- Earth, groundwater, bulk materials with variable character [H~]
- Rain load [R]
- Fluid [F]

2.3.2. Making the combinations

Once you have defined the load cases, you can make the load combinations

Click on [⚡ Generate all combinations automatically] . In the window appearing, you can check the combinations you want Diamonds to make:

- Load cases, so you can see the effect of the load cases separately on the construction.
- **'Strength'** combinations, for calculation reinforcement and steel verification (comparable with ULS)
- **'Service'** combinations, for deflection verification (comparable with SLS).
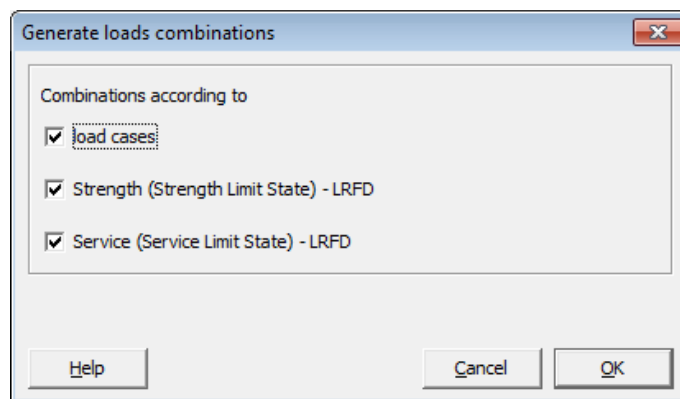
Remarks:

- The American design code for concrete ACI 318 and for steel ASCI LRFD are both according to the LRFD principle and are implemented in Diamonds. These codes can complete you model with load cases according to ASCE 7-10.

3. Elastic analysis

3.1. Extra parameters for mesh

As of Diamonds 2012 R01, the mesh dialog window looks as follows:
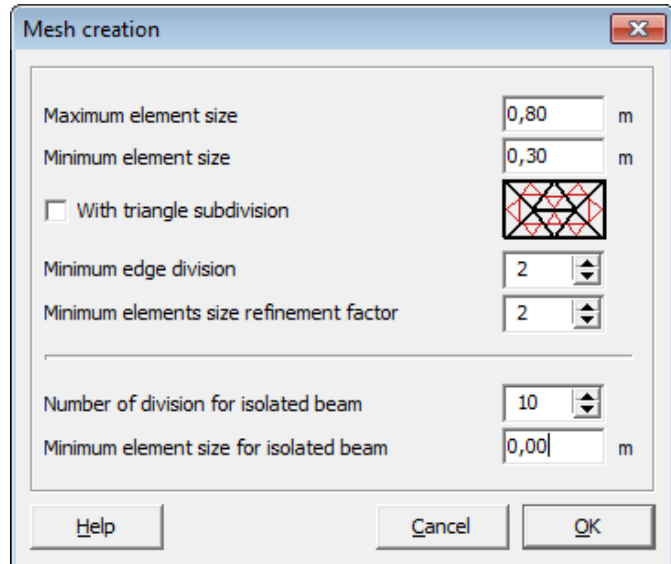
The parameters 'Minimum edge division' and 'Minimum elements size refinement factor' are new (the other parameters have kept their function):

- With 'Minimum edge division' you can indicate in how many pieces at least you want each border to be divided.
- If you enter a value other than '1' for 'Minimum elements size refinement factor', Diamonds will recalculate the mesh for all plated without internal mesh nodes. This second mesh size will be:

$$Maximum\ element\ size\ 2nd\ mesh\ = \frac{Maximum\ element\ size}{Minimum\ elements\ size\ refinement\ factor}$$

$$Minium\ element\ size\ 2nd\ mesh = \frac{Minium\ element\ size}{Minimum\ elements\ size\ refinement\ factor}$$

These 2 parameters prove their use in models with both big and little plates. If you choose a rather big size mesh, you will still get a descent mesh for the little plates too.

If you set both parameters on '1', you will get a mesh comparable with a mesh in Diamonds 2012.

3.2. Modifications on soil layer calculation

When you add a new soil layer profile, you see the window below:
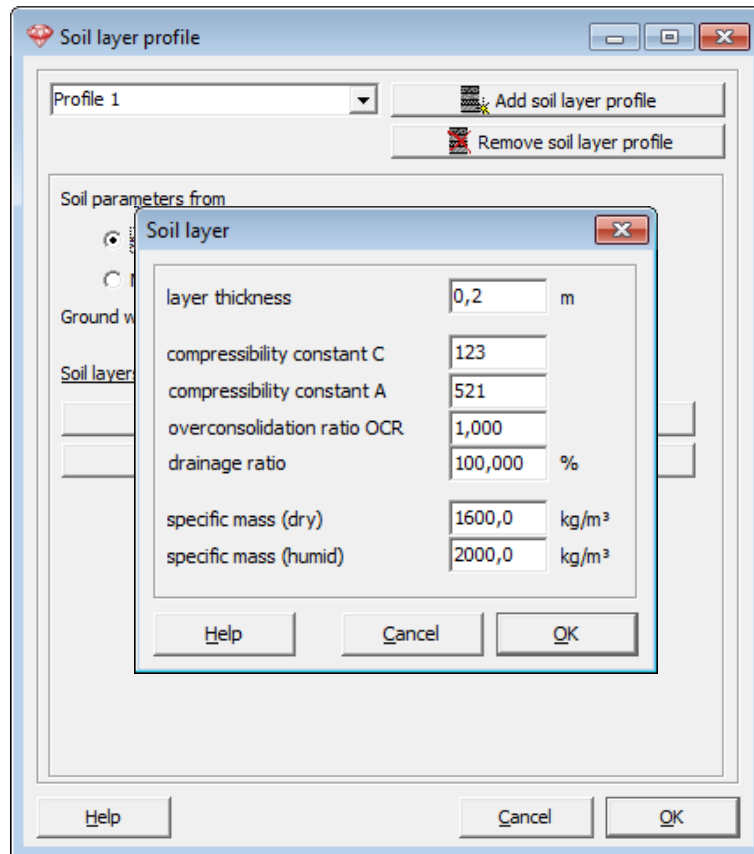
Let us look at the parameters to complete:

- Layer thickness [m]
- Compressibility constant C [-]: this parameter gives an idea about the soil layer compressibility in normal conditions. Usually this parameter is given in the sounding report, where it is calculated as:

$$C = \frac{\alpha \cdot q_c}{\sigma'_{v0}}$$

  With $\alpha = 1,5$ (default value in sounding report), q_c cone resistance σ'_{v0} vertical granular stress

- Compressibility constant A [-]: this parameter gives an idea about the soil layer compressibility when this layer has been charged before (or is overconsolidated). This parameter is calculated the same way as C, but α can have another value.

Soil type	q_c [MPa]	α for determination of C	α for determination of A
Low-plasticity clay	$q_c \leq 0,7$ $0,7 < q_c < 2$ $q_c < 2$	$3 < a < 8$ $2 < a < 5$ $1 < a < 2,5$	4,5
Low-plasticity silt	$q_c < 2$ $q_c > 2$	$3 < a < 6$ $1 < a < 2$	$6 < a < 7,5$
Very plastic clay and silt	$q_c < 2$ $q_c > 2$	$2 < a < 6$ $1 < a < 2$	
Very organic silt	$q_c < 1,2$	$2 < a < 8$	
Peat and very organic clay	$q_c < 0,7$ $50 < w \leq 100$ $100 < w \leq 200$ $w > 300$	$1,5 < a < 4$ $1 < a < 1,5$ $a < 0,4$	1,0
Chalk	$2 < q_c \leq 3$ $q_c > 3$	$2 < a < 4$ $1,5 < a < 3$	
Sand	$q_c > 10$	$1,5 < a < 2$	$12 < a < 15$

Table 1: Values for α (columns 1-3 see EN 1997-1-2 Table D.2)

- Overconsolidation ratio OCR [-]: this parameter takes into account the effect of preloading (or overconsolidation) of the soil

$$OCR = \frac{effective\ maximal\ stress\ in\ the\ past}{effective\ current\ stress,\ before\ excavation}$$

- • If the soil has been loaded in the past (example: an ancient building that will be broken down, taking a big pile of sand away), the overconsolidation ratio is greater than 1.
- • If the soil has not been preloaded, the overconsolidation ratio equals 1.

The overconsolidation ratio OCR can have a different value per soil layer. That way you can enter a soil profile consisting of existing (overconsolidated) soil and newly placed soil.

Attention: for excavation, you do NOT have to change l'OCR. Diamonds will take this automatically into account.

If you do not know what to enter for OCR, the best value to choose is '1'.

- Drainage ratio CC [-]: is a measurement of how much of the pore water is already drained. This parameter depends on the type of soil and the depth of the layer. Some examples:
  - • For a foundation pit that is being drained, CC will be à 100%
  - • Sand is almost immediately drained, so CC will be approximately 100%
  - • Thin top layers of clay will drain quite quickly, CC will between 50 and 75%
  - • Thick lower layers of clay will drain rather slow, so CC will be between 25 and 50%
  - • For thick, deep layers of clay, the drainage will take a very long time, so CC will be between 0 and 25%
  - • If you do not know what to enter for CC, the best (and safest) value to choose is '100%'.

- Specific mass dry γ_{sec} [kg/m^3]
- Specific mass wet γ_{humide} [kg/m^3]

Remarks:

- These parameters are only for use with cone penetration test results CPT.
- It is possible to import in Diamonds 2012 01 a .TXT file with the complete soil profile according to the old system (up to Diamonds 2012). The extra parameters will get a safe value ($A = C, OCR = 1, CC = 100\%$). TXT files with soil profile according to the new system are not compatible with elder versions of Diamonds.

4. Design

4.1. Buckling length calculation

Before calculating the reinforcement (for concrete structures) or executing resistance/buckling verification (for a steel or timber structure), you start with the buckling length calculation.

When you click the icon ![icon] for calculation buckling lengths, you will see following dialog window as from Diamonds 2012 R01:
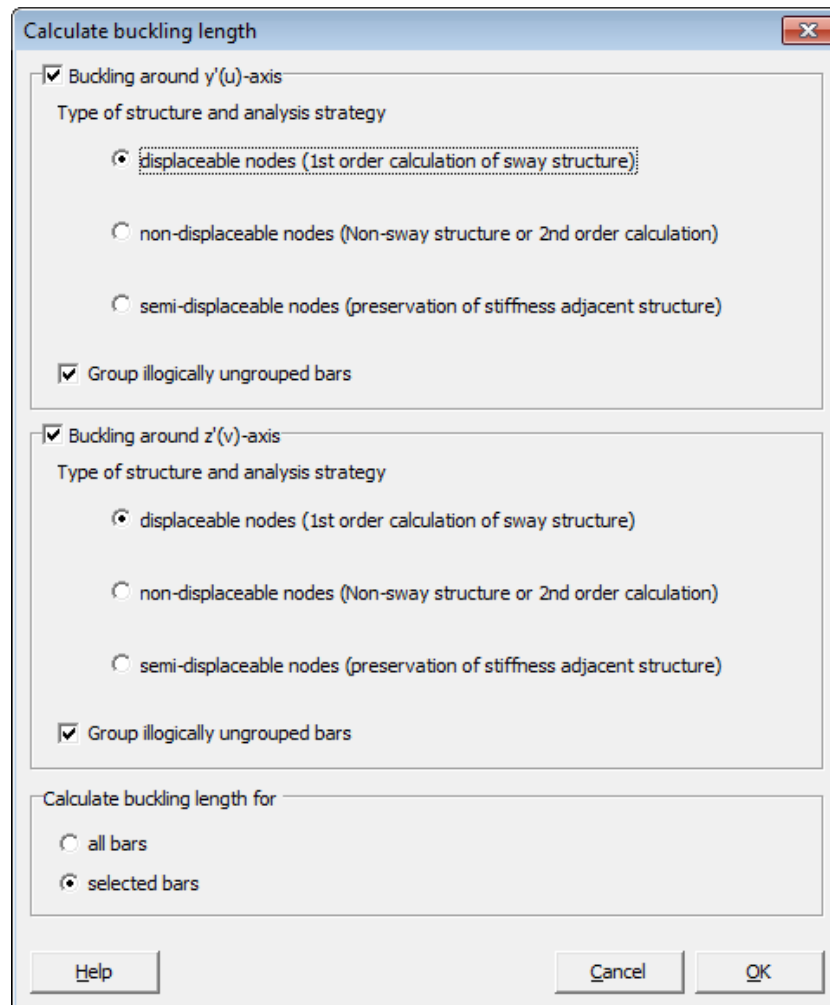
You can calculate the buckling lengths about the strong axis y'(u) and about the weak axis z'(v). For each buckling direction, you can:

- Indicate whether or not the buckling lengths should be calculated about this axis. If you do not check this option, buckling lengths will not be calculated.
- Choose the scenario for calculation of buckling length:
  o **Non-displaceable nodes** – to be used in the case of 2nd order calculation or to be used during the 1st order analysis of a frame without bracing. This calculation always gives the smaller buckling lengths than the length of the system.

- o **displaceable nodes** (in this case, we do not take into account the rigidity of the rest of the adjacent structure, but all the bars under compression lose simultaneously their stability at the buckling) – to be used with a 1st order calculation of a braced frame. This buckling length calculation generates an evaluation that is both conservative and possible.
  - o **Semi-displaceable** nodes (with preservation of the rigidity of the adjacent structure) – to be used in the case of analysis of the 1st order of a braced frame.

- Also new is the option 'Group illogically ungrouped bars'. If this box is checked, bars

  - Lying on the same axis, without any support, nor other bars connected
  - And defined as 'ungrouped'

  Will be considered as grouped.
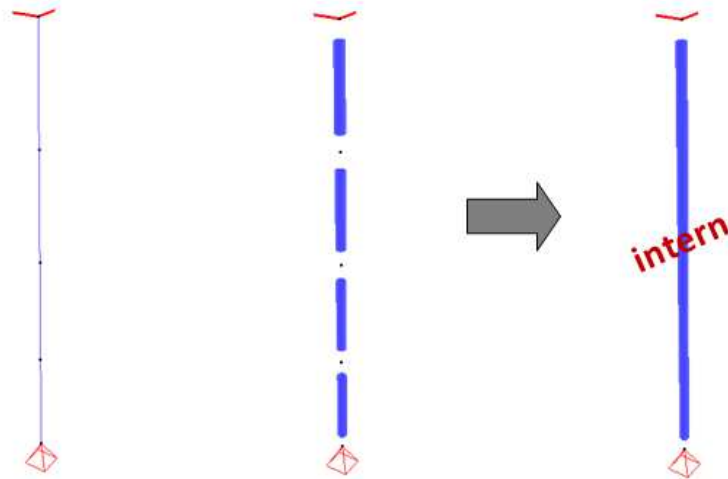
Finally, you can calculate the buckling lengths for all bars, or just the selected ones.

4.2. Modification in the steel verification EN 1993-1-1

4.2.1. Configuration of lateral torsional supports

4.2.1.1. Automatic definition of lateral torsional supports

A priori, Diamonds always considers the presence of a certain number of supports so that you need to introduce minimum modifications. In order to do this, the following general rules always apply:

The bar ends for which a support (regardless of the number of liberty degrees) has been defined are automatically provided with lateral buckling supports. This is also the case if the bar end serves as a joint with another bar that is not in the prolongation of the first one. On the other hand, bar ends that are free or assure a joint between two bars in prolongation of each other (and without another bar joining them in this point), are not provided with lateral buckling supports. In the case

of a bar with a free end, we will take the lateral buckling length corresponding to the double length of the bar into consideration.

Automatic definition of a LT support
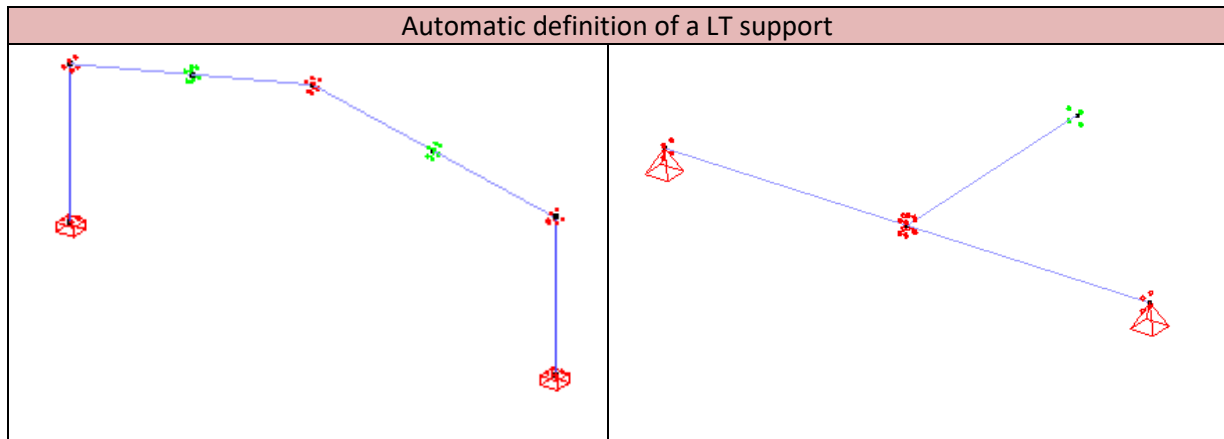
The automatic LT supports placed following the rules above are for both upper and lower flange.

You can visualize the lateral buckling supports on checking the options 'LT supports z>0' and 'LT supports z<0' in the window configuration .
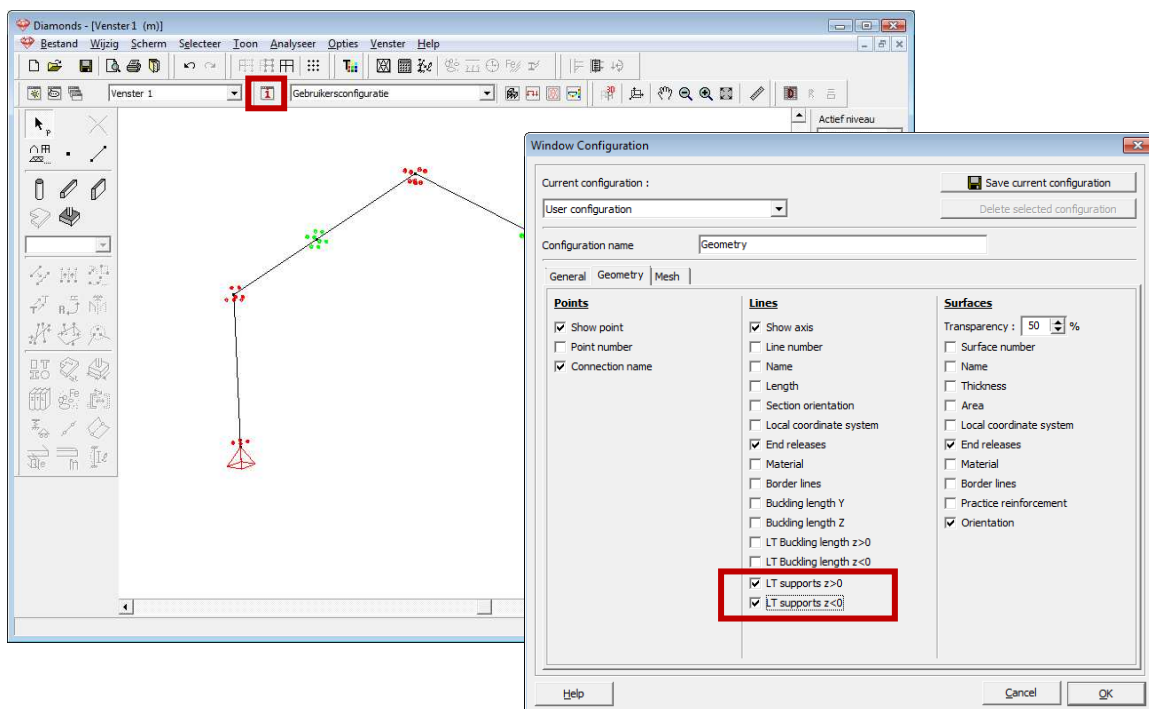
4.2.1.2. Modification of lateral torsional supports

You can of course edit at all times the definition of LTB supports. Select the bar and click on . You will see following dialog window:
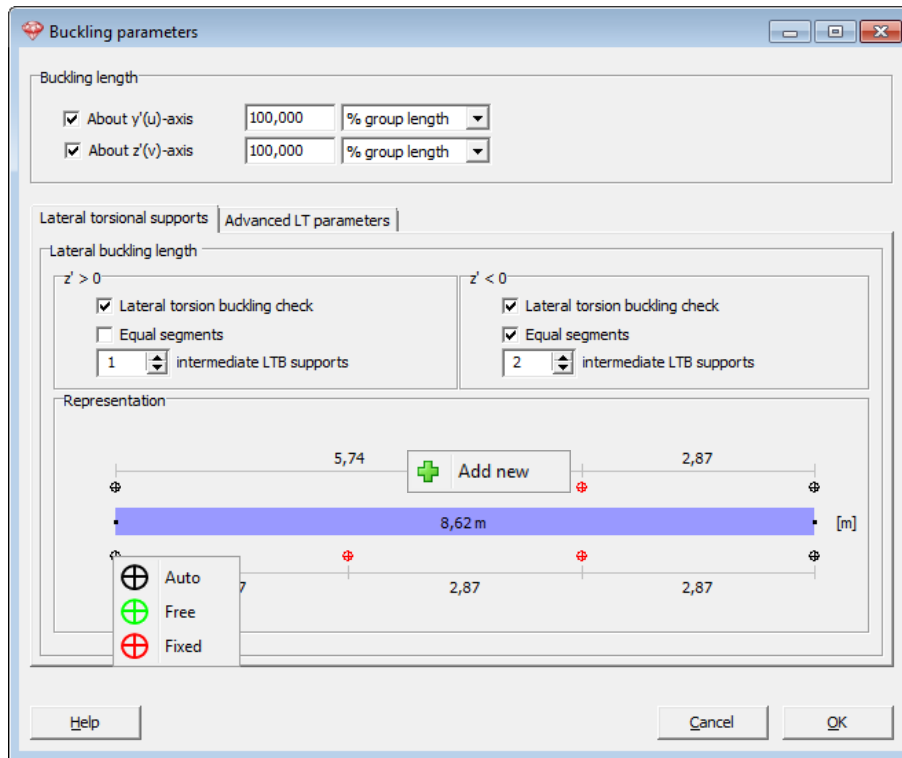
- In the **upper part**, you'll see the buckling length
- In the **lower part**, you can configure the necessary parameters for lateral buckling. Let us start on the tab 'Lateral torsional supports'.
- With the option ☑ Lateral torsion buckling check , you can decide whether or not you want to verify lateral torsion buckling for the upper side (z'>0) or lower side (z'<0).
 If you do want a lateral torsion buckling verification, you can indicate the number of LTB supports present. You can modify the definition of a LTB support at bar ends, by simply clicking with your left mouse button on the support. You can now choose between an automatic, free or fixed support. You can also add **intermediate LTB supports** by increasing the number of supports ▐ 2 ▐ intermediate LTB supports or clicking with the right mouse button in the corresponding field ╬ Add new .

  On checking the option ☑ Equal segments , Diamonds will place all supports on equals distances relative to each other. If you uncheck this option, you can manually edit the distances by entering a value in the input field – click on the value to see the input field. You can also move the support by clicking the support once. Now you can slide the support to the right distance.
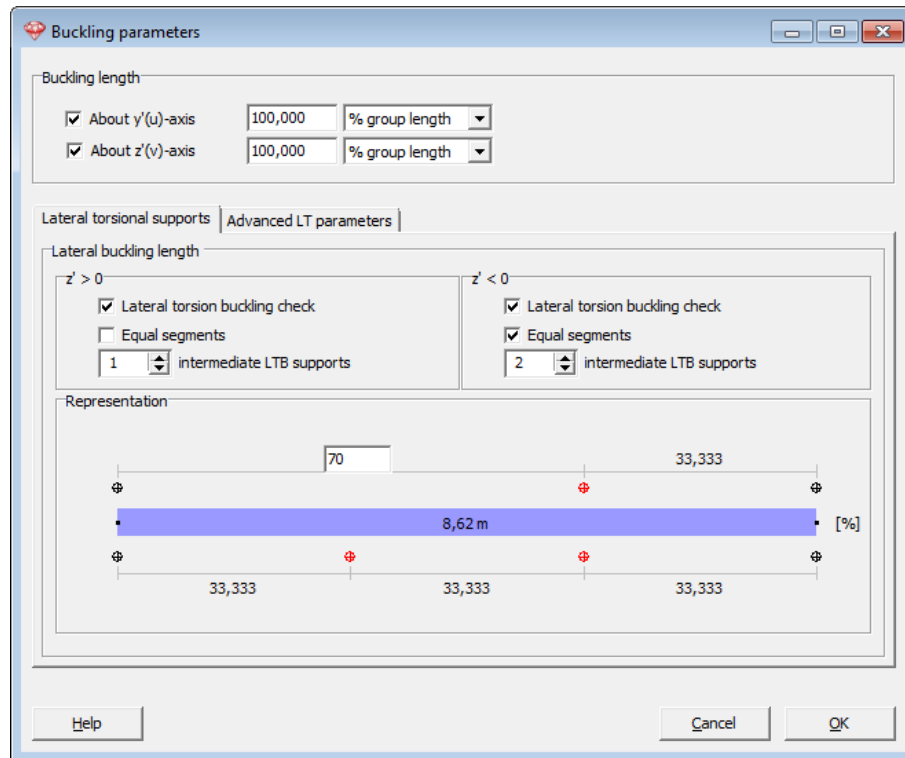
If the button [m] is visible, you enter distances in absolute values. Clicking on this button [m], will change the button into [%]. You can now enter distances in relative values (percentages).

- Remark: In the Netherlands, there is a difference between a 'fork' support and a lateral support.
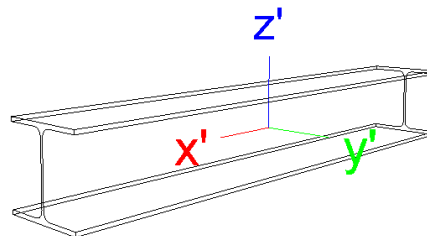
- A fork support prevents translation in the y' direction and rotation around the x' axis.
- A lateral support prevents translation in the y' direction.

Diamonds will recognize:

- A fork support when there is a LTB supports on upper AND lower flange
- A lateral support when there is a LTB support on upper OR lower flange

Based on that information, Diamonds will calculate the buckling lengths according to NEN - EN 1993-1-1 Annex D.4.3.

4.2.2. Advanced lateral torsional parameters

By default, Diamonds considers the presence of a certain number of supports against the lateral-torsional buckling, especially at the bar ends. However, you can modify these boundary conditions at any time in the tab 'Advanced LT parameters'.
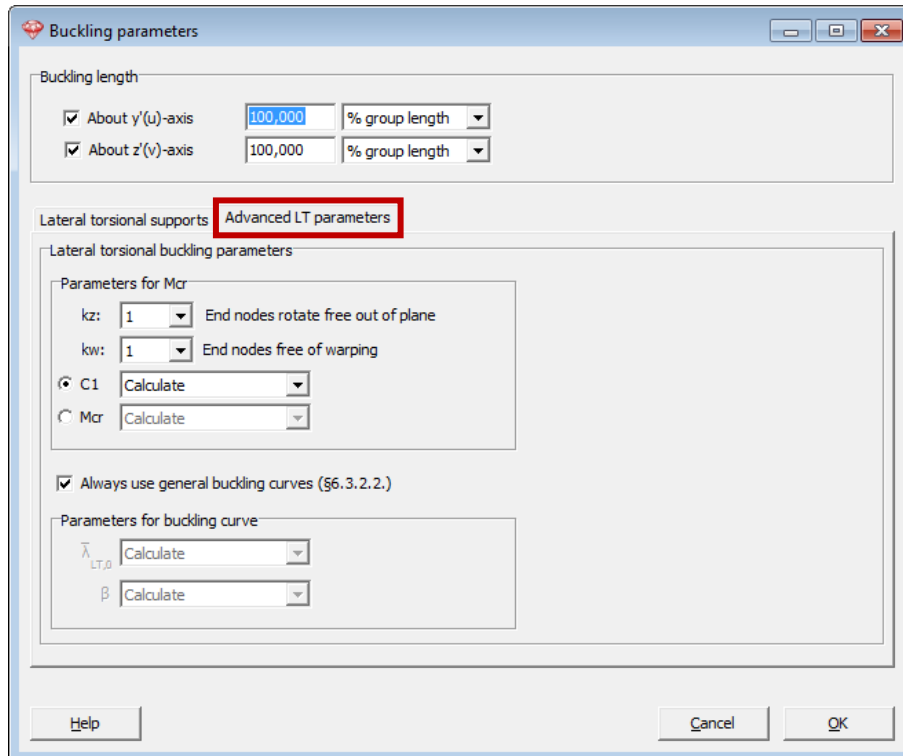
You can start with entering the parameters for the determination of the elastic critical buckling moment:

- Or you specify k_z and k_w and the coefficient C_1, in order to let Diamonds calculate elastic critical buckling moment M_{cr}.
- Or you specify elastic critical buckling moment M_{cr}

Finally, you can specify the method for determination of buckling curves. You can choose between:

- The general method EN 1993-1-1 §6.3.2.2
- The equivalent method EN 1993-1-1 §6.3.2.3.

See next section.

4.2.1. Lateral buckling verification

As from Diamonds 2012 R01, you can choose which lateral buckling curve to be used on lateral buckling verification. The scheme below shows where these lateral buckling curves play a role.

$$\frac{M_{Ed}}{M_{b,Rd}} \leq 1.0$$

$$M_{b,Rd} = \frac{\chi_{LT} W_y f_y}{\gamma_{M1}}$$

- $W = W_{pl}$ for sections class 1 &t 2
- $W = W_{el,min}$ for sections class 3
- $W = W_{eff,min}$ for sections class 4

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \bar{\lambda}_{LT}^2}} \leq 1.0$$

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta \bar{\lambda}_{LT}^2}} \leq \begin{cases} 1.0 \\ \frac{1}{\bar{\lambda}_{LT}^2} \end{cases}$$

$$\Phi_{LT} = 0.5 \left[1 + \alpha_{LT}(\bar{\lambda}_{LT} - 0.2) + \bar{\lambda}_{LT}^2\right]$$

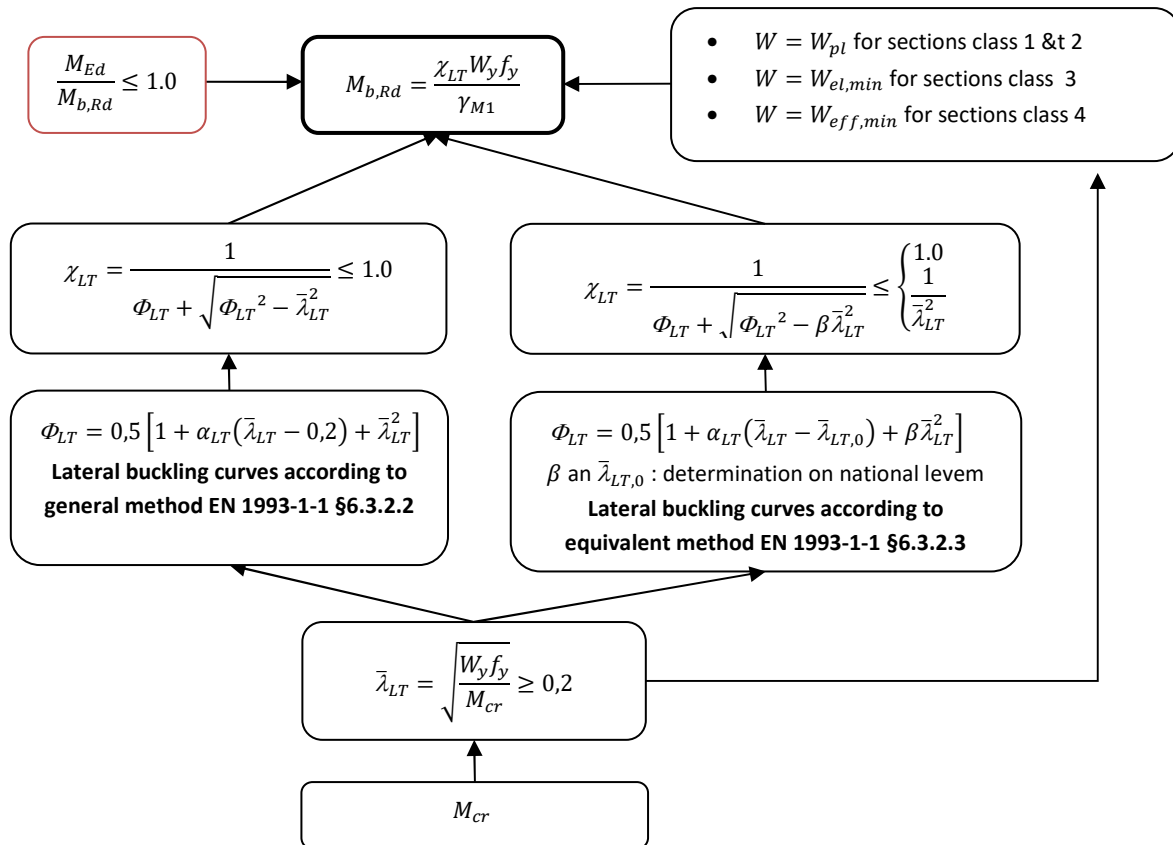**Lateral buckling curves according to general method EN 1993-1-1 §6.3.2.2**

$$\Phi_{LT} = 0.5 \left[1 + \alpha_{LT}(\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta \bar{\lambda}_{LT}^2\right]$$

β an $\bar{\lambda}_{LT,0}$: determination on national levem

Lateral buckling curves according to equivalent method EN 1993-1-1 §6.3.2.3

$$\bar{\lambda}_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}} \geq 0.2$$

$$M_{cr}$$

Remarks:

- Indicate your lateral buckling curve choice according to EN 1993-1-1 §6.3.2.2 or §6.3.2.3. in the buckling window.
  In the equivalent method EN 1993-1-1 §6.3.2.3, the determination of the lateral buckling curves is not applicable for all types of sections (f.e.: yes for I, H sections, but not for L, T, O, …). If you decide to determine the lateral buckling curves with this method, Diamonds will use this method for all sections possible. If it is not possible to use this method, Diamonds will use the general method to find the lateral buckling curves..
- The choice of lateral buckling curves also applies to interaction verifications, also known as 'buckling + lateral buckling' or 'normal force + moment'.
- Diamonds will use the general method EN 1993-1-1 §6.3.2.2 by default.
- Up to Diamonds 2012, the lateral buckling curved were determined with the general method EN 1993-1-1-§6.3.2.2

4.3. Optimization for timber and cold formed steel sections

When Diamonds conducts a verification of cross-sections, it obtains a percentage of the ability of bars to resist to forces they are subjected to. However, the first choice of cross-sections could made relatively randomly. It is therefore possible that a cross-section will be too big or too small depending on requests.

In order to spare the user a tedious work, Diamonds offers routines for optimization of cross-sections to assure the best adequacy between, on one hand, the resistance and, on the other hand, the cost. As from Diamonds 2012 R01, you can also use this procedure for the optimization of **timber** and **cold formed steel sections** (type SADEF).

Tip:

- It is best to create a section library with commonly used timber sections. The profiles that you will get when using 'optimization user defined section' will not always be available on the market.
- For **SADEF sections**, Diamonds makes a choice in the corresponding section group. Diamonds does not allow you to create a new group with cold formed sections.

ANNEX 1: COMBINATIONS ACCORDING TO AMERICAN STANDARD

Following **'STRENGTH'** combinations are generated:

Base 1	$1,4D$
	$1,4(D + F) + (0,9 \text{ or } 1,6)H$
Base 2	$1,2D + 1,6L + 0,5(L_r \text{ or } S \text{ or } R)$
2a	$1,2(D + F) + 1,6L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)L_r$
2b	$1,2(D + F) + 1,6L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)S$
2c	$1,2(D + F) + 1,6L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)R$
Base 3	$1,2D + 0,5(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
3a	$1,2(D + F) + 0,5L_r + (0,9 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3b	$1,2(D + F) + 0,5S + (0,9 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3c	$1,2(D + F) + 0,5R + (0,9 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3d	$1,2(D + F) + 0,5L_r + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
3e	$1,2(D + F) + 0,5S + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
3f	$1,2(D + F) + 0,5R + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
Base 4	$1,2D + 1,0W + L + 0,5(L_r \text{ or } S \text{ or } R)$
4a	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)L_r$
4b	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)S$
4c	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,5)R$
~~Base 5~~	~~$1,2D + E + L + 0,2S$~~
~~5~~	~~$1,2(D + F) + E + (0 \text{ or } 1)L + (0,9 \text{ or } 1,6)H + (0 \text{ or } 0,2)S$~~
Base 6	$0,9D + W$
6	$0,9D + W + (0,9 \text{ or } 1,6)H$
~~Base 7~~	~~$0,9(D + F) + E$~~
~~7~~	~~$0,9(D + F) + E + (0,9 \text{ or } 1,6)H$~~

Table 3: Combinations when H is a permanent load

Base 1	$1,4D$
1	$1,4(D + F) + (0 \text{ or } 1,6)H$
Base 2	$1,2D + 1,6L + 0,5(L_r \text{ or } S \text{ or } R)$
2a	$1,2(D + F) + 1,6L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)L_r$
2b	$1,2(D + F) + 1,6L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)S$
2c	$1,2(D + F) + 1,6L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)R$
Base 3	$1,2D + 0,5(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
3a	$1,2(D + F) + 0,5L_r + (0 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3b	$1,2(D + F) + 0,5S + (0 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3c	$1,2(D + F) + 0,5R + (0 \text{ or } 1,6)H + (0 \text{ or } 1)L$
3d	$1,2(D + F) + 0,5L_r + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
3e	$1,2(D + F) + 0,5S + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
3f	$1,2(D + F) + 0,5R + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)W$
Base 4	$1,2D + 1,0W + L + 0,5(L_r \text{ or } S \text{ or } R)$
4a	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)L_r$
4b	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)S$
4c	$1,2(D + F) + 1,0W + (0 \text{ or } 1)L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,5)R$
~~Base 5~~	~~$1,2D + E + L + 0,2S$~~
~~5~~	~~$1,2(D + F) + E + (0 \text{ or } 1)L + (0 \text{ or } 1,6)H + (0 \text{ or } 0,2)S$~~
Base 6	$0,9D + W$
6	$0,9D + W + (0 \text{ or } 1,6)H$
~~Base 7~~	~~$0,9(D + F) + E$~~
~~7~~	~~$0,9(D + F) + E + (0 \text{ or } 1,6)H$~~

Table 4: Combinations when H is a variable load

Remarks:

- The load type H (Earth, groundwater, bulk materials) can have a variable or permanent character, which can produce different safety factors. That is way there are 2 tables: Table 3 **Fout! Verwijzingsbron niet gevonden.** when H is a permanent load and Table 4, when H is a variable load.
- There are 7 basic equations for generating the load combinations. In function of the loads considered, safety factors … these base equations produce sub-equations (in white). The white equations are implemented in Diamonds
- On selecting the load type "$L <$" (live load), the safety factor takes the value 0.5 instead of 1.0 in the basic equations 3, 4 and 5.
- Combination 'Strength' according to the basic equations 5 and 7 will not be generated, as Diamonds has not yet a Dynamic module available.
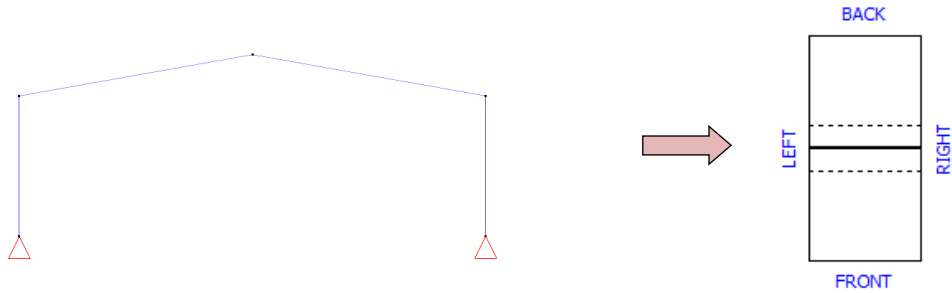
Following **'SERVICE'** combinations are generated:

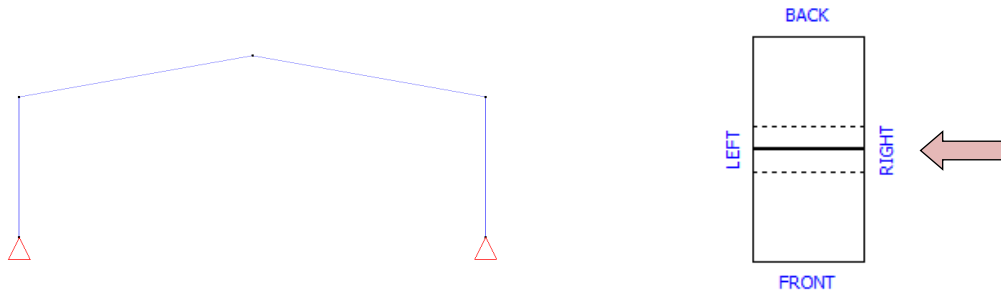| CC-1a	$D + L$
	$D + L$
CC-1b	$D + S$
	$D + S$
CC-2	$D + 0,5L + W_a$
	$D + (0 \ or \ 0,5)L + (0 \ or \ 1)W_a$

Remarks:

- There are 3 basic equations for generating the load combinations. In function of the loads considered, safety factors, these base equations produce sub-equations (in white). The white equations are implemented in Diamonds
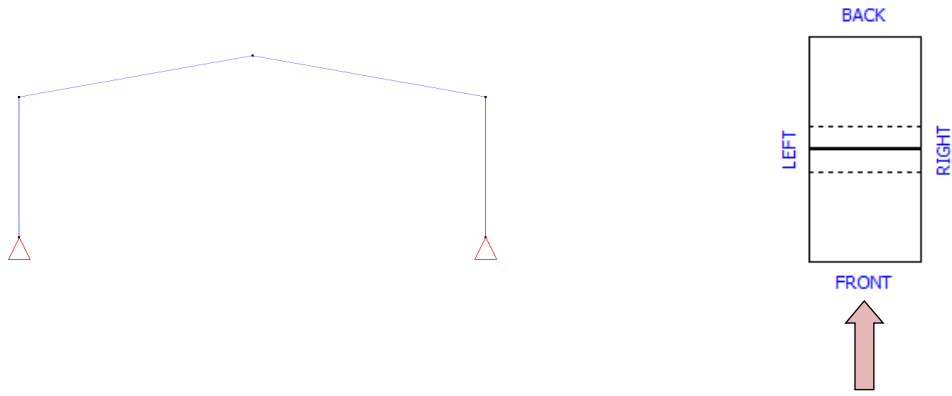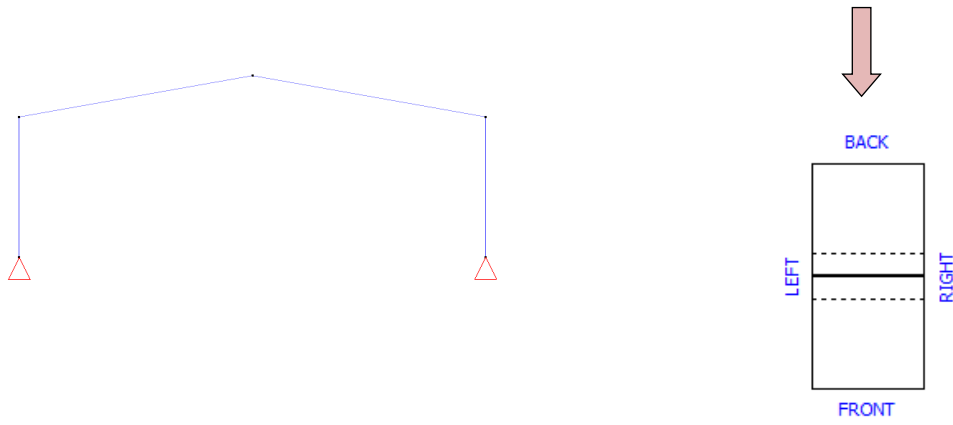
ANNEX 2: WIND LOADS

Gable roof: 24 cases

	EXTERNAL PRESSURE c_{pe}		INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$		POSSIBLE NAME FOR THIS LOAD CASE
WIND LEFT TO RIGHT	$c_{pe} -$ $c_{pe} -$	+	$c_{pi} -$	=	left asc → right asc (c_{pi}-)
	$c_{pe} -$ $c_{pe} +$	+	$c_{pi} -$	=	left asc → right desc (c_{pi}-)
	$c_{pe} +$ $c_{pe} -$	+	$c_{pi} -$	=	left desc → right asc (c_{pi}-)
	$c_{pe} +$ $c_{pe} +$	+	$c_{pi} -$	=	left desc → right desc (c_{pi}-)
	$c_{pe} -$ $c_{pe} -$	+	$c_{pi} +$	=	left asc → right asc (c_{pi}+)
	$c_{pe} -$ $c_{pe} +$	+	$c_{pi} +$	=	left asc → right desc (c_{pi}+)
	$c_{pe} +$ $c_{pe} -$	+	$c_{pi} +$	=	left desc → right asc (c_{pi}+)
	$c_{pe} +$ $c_{pe} +$	+	$c_{pi} +$	=	left desc → right desc (c_{pi}+)

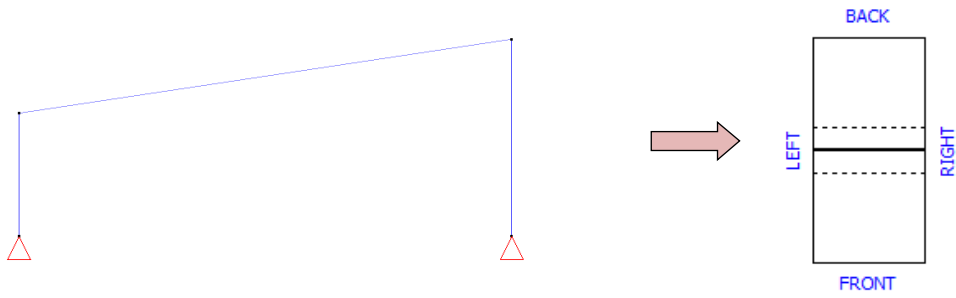|	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OU $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND RIGHT TO LEFT	$c_{pe} -$ $c_{pe} -$ +	$c_{pi} -$ =	right asc → left asc (c_{pi}-)
	$c_{pe} -$ $c_{pe} +$ +	$c_{pi} -$ =	right asc → left desc (c_{pi}-)
	$c_{pe} +$ $c_{pe} -$ +	$c_{pi} -$ =	right desc → left asc (c_{pi}-)
	$c_{pe} +$ $c_{pe} +$ +	$c_{pi} -$ =	right desc → left desc (c_{pi}-)
	$c_{pe} -$ $c_{pe} -$ +	$c_{pi} +$ =	right asc → left asc (c_{pi}+)
	$c_{pe} -$ $c_{pe} +$ +	$c_{pi} +$ =	right asc → left desc (c_{pi}+)
	$c_{pe} +$ $c_{pe} -$ +	$c_{pi} +$ =	right desc → left asc (c_{pi}+)
	$c_{pe} +$ $c_{pe} +$ +	$c_{pi} +$ =	right desc → left desc (c_{pi}+)

	EXTERNAL PRESSURE c_{pe}		INTERNAL PRESSURE $c_{pi,-}$ OU $c_{pi,+}$		POSSIBLE NAME FOR THIS LOAD CASE
WIND FRONT TO BACK	c_{pe} — c_{pe} —	+	c_{pi} —	=	front → back asc (c_{pi}-)
	c_{pe} — c_{pe} —	+	c_{pi} —	=	front → back desc (c_{pi}-)
	c_{pe} — c_{pe} —	+	c_{pi} +	=	front → back asc (c_{pi}+)
	c_{pe} — c_{pe} —	+	c_{pi} +	=	front → back desc (c_{pi}+)

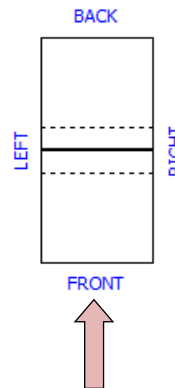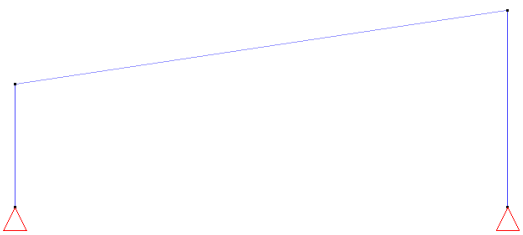|	EXTERNAL PRESSURE c_{pe}		INTERNAL PRESSURE $c_{pi,-}$ OF $c_{pi,+}$		POSSIBLE NAME FOR THIS LOAD CASE
WIND BACK TO FRONT	$c_{pe}-$ $c_{pe}-$	+	$c_{pi}-$	=	back → front asc (c_{pi}-)
	$c_{pe}-$ $c_{pe}-$	+	$c_{pi}-$	=	back → front desc (c_{pi}-)
	$c_{pe}-$ $c_{pe}-$	+	$c_{pi}+$	=	back → front asc (c_{pi}+)
	$c_{pe}-$ $c_{pe}-$	+	$c_{pi}+$	=	back → front desc (c_{pi}+)

Pent roof: 10 cases

	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND LEFT TO RIGHT	$c_{pe} -$	$+$ $\quad c_{pi} -$	$=$ left → right asc (c_{pi}-)
	$c_{pe} +$	$+$ $\quad c_{pi} -$	$=$ left → right desc (c_{pi}-)
	$c_{pe} -$	$+$ $\quad c_{pi} +$	$=$ left → right asc (c_{pi}+)
	$c_{pe} +$	$+$ $\quad c_{pi} +$	$=$ left → right desc (c_{pi}+)
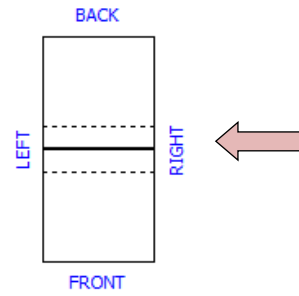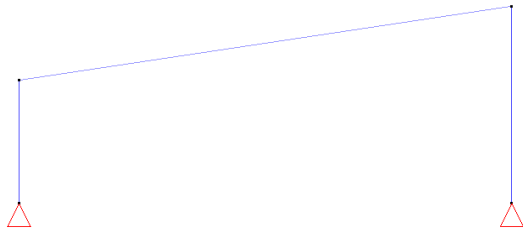
	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND RIGHT TO LEFT	$c_{pe} -$	$+$ $c_{pi} -$	$=$ right → left asc (c_{pi}-)
	$c_{pe} -$	$+$ $c_{pi} +$	$=$ right → left asc (c_{pi}+)

	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND FRONT TO BACK	$c_{pe} -$	$+$ $c_{pi} -$	$=$ front → back asc (c_{pi}-)
	$c_{pe} -$	$+$ $c_{pi} +$	$=$ front → back asc (c_{pi}+)
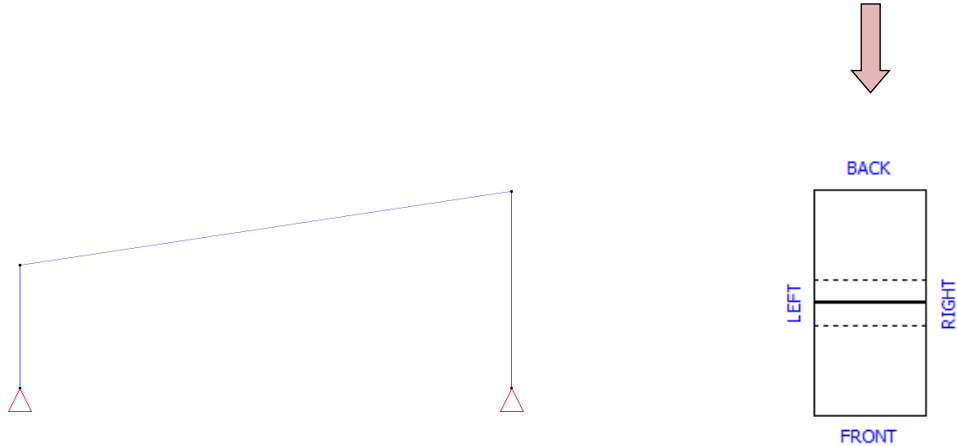
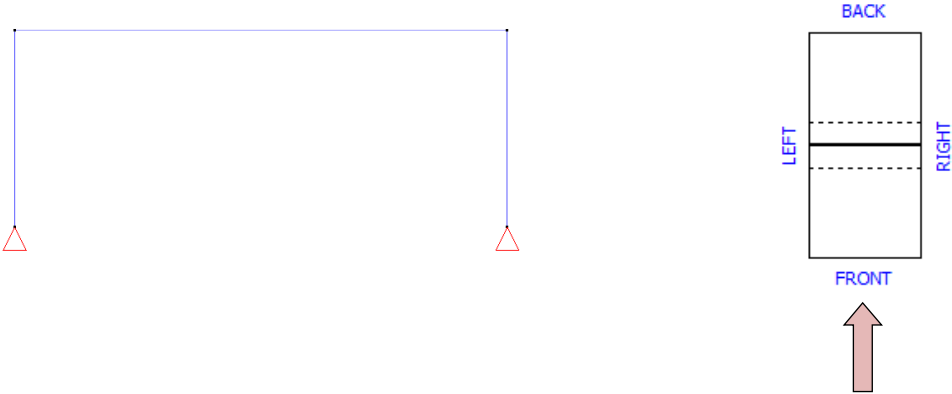|	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND BACK TO FRONT	$c_{pe}-$	+ $c_{pi}-$	= back → front asc (c_{pi}-)
	$c_{pe}-$	+ $c_{pi}+$	= back → front asc (c_{pi}+)

Flat roof: 12 cases
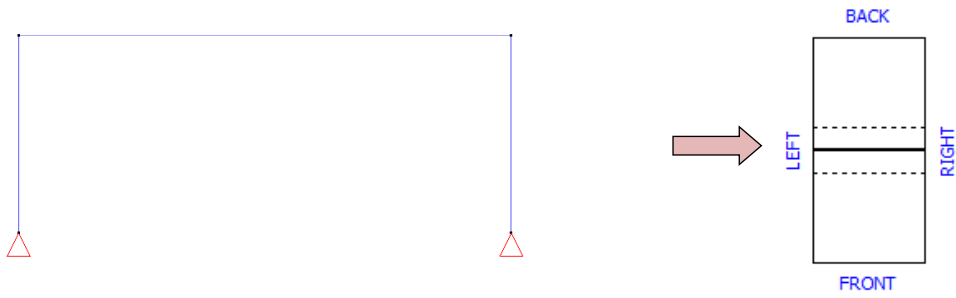
	EXTERNAL PRESSURE c_{pe}		INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$		POSSIBLE NAME FOR THIS LOAD CASE
WIND LEFT TO RIGHT	$c_{pe} -$ $c_{pe} -$	+	$c_{pi} -$	=	left asc → right asc w (c_{pi}-)
	$c_{pe} -$ $c_{pe} +$	+	$c_{pi} -$	=	left asc → right desc (c_{pi}-)
	$c_{pe} -$ $c_{pe} -$	+	$c_{pi} +$	=	left asc → right asc (c_{pi}+)
	$c_{pe} -$ $c_{pe} +$	+	$c_{pi} +$	=	left asc → right desc (c_{pi}+)

	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND RIGHT TO LEFT	$c_{pe} -$ $c_{pe} -$ +	$c_{pi} -$	= right asc → left asc (c_{pi}-)
	$c_{pe} +$ $c_{pe} -$ +	$c_{pi} -$	= right asc → left desc (c_{pi}-)
	$c_{pe} -$ $c_{pe} -$ +	$c_{pi} +$	= right asc → left asc (c_{pi}+)
	$c_{pe} +$ $c_{pe} -$ +	$c_{pi} +$	= right asc → left desc (c_{pi}+)

	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND FORNT TO BACK	$c_{pe} -$	$+$ $c_{pi} -$	$=$ front → back asc (c_{pi}-)
	$c_{pe} -$	$+$ $c_{pi} -$	$=$ front → back desc (c_{pi}-)
	$c_{pe} -$	$+$ $c_{pi} +$	$=$ front → back asc (c_{pi}+)
	$c_{pe} -$	$+$ $c_{pi} +$	$=$ front → back desc (c_{pi}+)

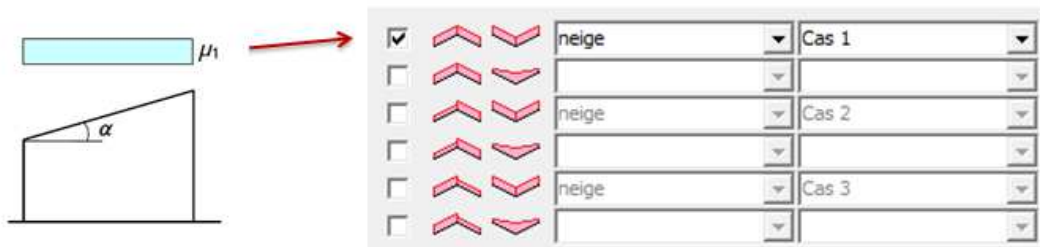|	EXTERNAL PRESSURE c_{pe}	INTERNAL PRESSURE $c_{pi,-}$ OR $c_{pi,+}$	POSSIBLE NAME FOR THIS LOAD CASE
WIND BACK TO FRONT	$c_{pe}-$ +	$c_{pi}-$ =	back → front asc (c_{pi}-)
	$c_{pe}-$ +	$c_{pi}-$ =	back → front desc (c_{pi}-)
	$c_{pe}-$ +	$c_{pi}+$ =	back → front asc (c_{pi}+)
	$c_{pe}-$ +	$c_{pi}+$ =	back → front desc (c_{pi}+)

ANNEX 3: SNOW LOADS

According to EN 1991-1-3 §5.3, we can distinguish different cases of snow loads, depending on the type of roof:
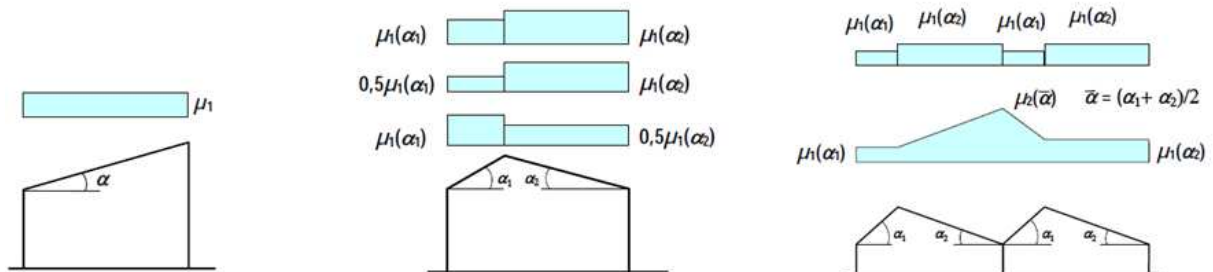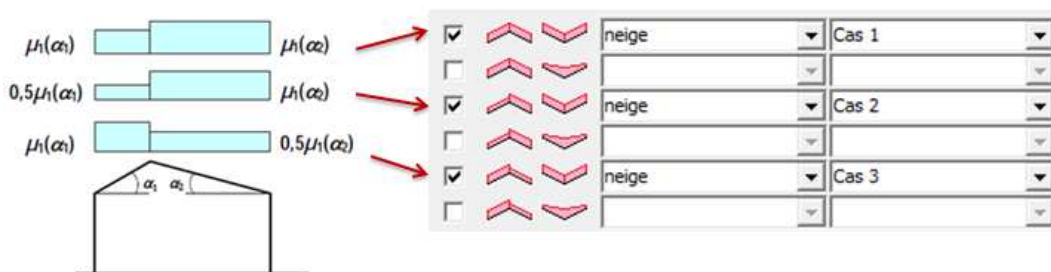

You can generate each of these cases with the Diamonds 2012 R01 snow generator.

- A flat or a pent roof

- A gable roof

- Multiple roofs

Les règles pour toiture deux versants sont appliquées aux portiques extrêmes